THE LORICATES OF THE NEW CALEDONIAN REGION.

(Class MOLLUSCA—Order LORICATA.)

By A. F. Basset Hull and Jean Risbec, D.Sc.

Plate xx.

Prefatory Note.

During August and September, 1925, I visited New Caledonia, collecting in the vicinity of Noumea, on the south-western coast, and Bourail, on the central western coast. Nine days were spent on a visit to the Loyalty Islands, collecting being carried out on Mare and Lifû.

From July to September, 1926, another visit was paid to New Caledonia, and, with more time at my disposal, I was able to conduct more intensive collecting around Noumea, besides spending twelve days on a trip up the eastern coast, as far as the Island of Pam, during which I collected at Tchio, Wagap and other ports of call.

On both occasions I had the advice and assistance of M. Jean Risbec, then Professeur at the College, La Perouse, Noumea, who was occupying his leisure in a study of the New Caledonian Nudibranchs. He subsequently visited Paris and published an exhaustive monograph of this Molluscan group, presenting it as a thesis, for which he gained the degree of Docteur ès-Sciences. He very kindly examined and made drawings of the radulas of the New Caledonian Loricates which I had collected, and agreed to collaborate with me in the production of the following account of the latter group. He has collected at many localities I was unable to visit, and has critically examined the breeding of some species under captive conditions in aquaria. The dissection and drawing of the internal organs are his work.

—A. F. Basset Hull.

The New Caledonian Region.

For the purpose of this account the New Caledonian region embraces the Island of New Caledonia and its Dependencies, including the Islands of Pott and Art in the extreme north, the Isle of Pines in the extreme south, and the Loyalty Islands, about 50 miles to the eastward of New Caledonia. the whole region being between 161° and 166° east longitude and 19° and 23° south latitude (Paris).

The main island and its immediate outliers are of extremely varied geological formation, with extensive barrier and fringing coral reefs. The Loyalty Islands are entirely of raised coral, Mare and Lifû showing at least four successive periods of uplift, evidenced by cliffs weathered into caves crowned by raised beaches.

This wealth of variety in the littoral rock is marked by an abundance of Loricate fauna in relation to the sedimentary rocks, and a notable scarcity in relation to the igneous rocks. The most prolific grounds exist in the south west, where the rocks are mostly limestone, quartzites and schists, with fringing coral reefs.

Previous Literature.

The literature of the New Caledonian Loricates is very scanty, consisting merely of descriptions of several species collected in the islands. Souverbie described six species, assigned to the New Caledonian region, in the Journal de Conchyliologie, 1866, 248-254, and 1873, 287. Rochebrune named ten species in the Bulletin de la Société Philomathique de Paris, 1881-1884. Both authors, however, have separately described species since found to be conspecific, and the latter author re-described some of Souverbie's species. Furthermore, Rochebrune's descriptions are almost useless, and his classification is, in several instances, obviously incorrect. Thiele (Revision Chitonen [Chun's Zoologica, heft 56] 1909-10) examined Rochebrune's types and revised both his nomenclature and classification.

Finally, Hedley described one species from the Isle of Pines (Proc. Linn. Soc. N.S.W., xxiii., 1900, 100, fig.). Full reference to previous descriptions will be found in the synonymy attached to each species herein described.

General Discussion as to the Relative Importance of Anatomical Characters, Considered as Specific or Generic Characters of the Loricata.

The Molluscan Order Loricata consists of an extremely homogeneous group, and all the genera present a closely related anatomical structure. In addition, the organs of separate individuals of the same species show great variability. These two facts in conjunction show how difficult it would be to distinguish the species if too great importance is attached to a study of the internal characters. The radula, in itself so characteristic in the Prosobranch group (notwithstanding important individual variations) can here be made use of only with difficulty. It is very variable in individuals of the same species, and it is also very difficult to study. The large second lateral, distinctly visible with its coloured cusps, and which seems to provide very clear and easily established characters, varies, alas! along the radular ribbon. The anatomical characters of the Loricata, therefore, provide only a secondary means of differentiation, and the study of the valves and the girdle remains the only certain basis for the grouping of the forms studied.

It seems, then, that following the animal groups, the conception of the genus may be variable. The established genera of the Loricata differ less among themselves (in regard to the less important characters) than those of the Prosobranchiate group, for example. The result of a study of the anatomical characters alone, according to the plan adopted in relation to the Prosobranchs, would be to cause all the Loricates to be united under one genus.

I. Family ISCHNOCHITONIDAE.

i. Genus Ischnochiton Gray, 1847.

1. Ischnochiton acomphus n.sp.

(a). *The Shell.*

Shell small,* elongate oval, elevated, semi-carinated, side slopes convex. Colour variable, creamy-buff, mottled with bluish-green, principally on the

---

Explanation of Figures.

Fig. 1.—Anterior part of the ventral surface of the body. a—mouth, b—buccal hood, c—foot, d—gill.

Fig. 2.—Posterior part of the ventral surface. a—anus, b—foot, c—gill.

Fig. 3.—View of a gill seen from the ventral surface; the point is directed towards the foot. Magnification: 40.

Fig. 4.—Sub-radular organ. Magnification: about 40.

Fig. 5.—View of the stomach drawn beneath the radular sac and observed laterally. The dotted part is that on which the radular sac rested. The surface, which is normally posterior, is in front in this figure, the anterior surface is beneath. a—oesophagus, b—stomach.

Fig. 6.—Stomachic region in its normal position. a—oesophagus, b—stomach, c—radular sac, d—papillary sacs, e—posterior part of bulb. Magnification: 25.

Fig. 7.—Papillae of the papillary sacs.

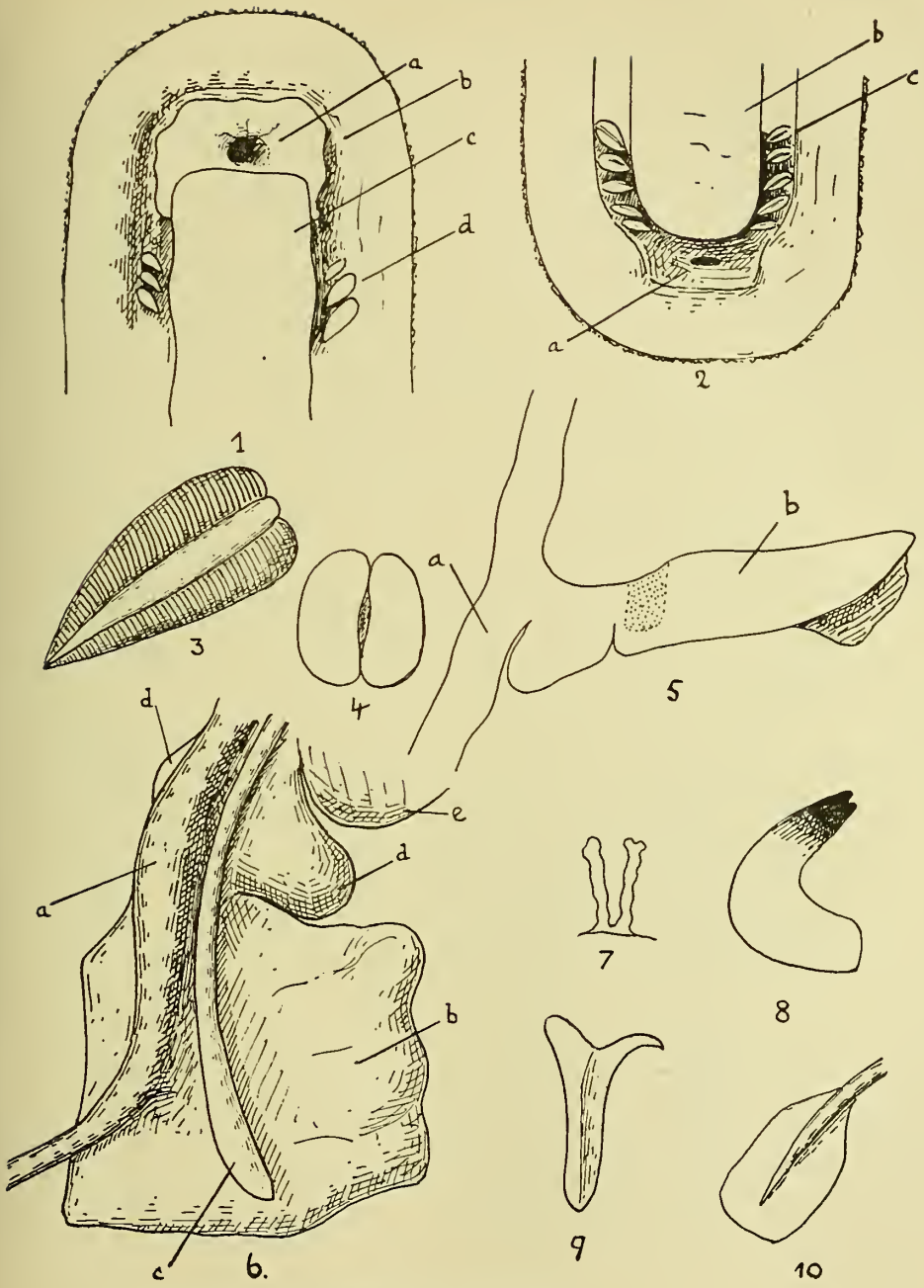
Fig. 8.—A view of the second lateral radular tooth.

Fig. 9.—Central radular tooth seen laterally. Magnification: 300.

Fig. 10.—Enlarged palate of the fourth lateral radular.

---

*We have adopted Iredale and Hull's "arbitrary standard" of measurement, viz.: "Small" means under 15 mm. for an average adult specimen; "Medium" over 15 and under 30 mm., and "Large" over 30 mm. in length.



ISCHNOCHITON ACOMPHUS.
Figs. 1 to 10.

sides of the jugum and on the outer margins of the valves (type); wholly creamy-buff, pink, or greenish, and these colours more or less extensively mottled with dark green, brown or black, sometimes in bilaterally symmetrical pattern, sometimes irregularly.

Anterior valve rayed with about thirty fine low ribs, formed by the apices of about fifteen concentric rows of irregularly shaped pustules, which diminish towards and finally disappear on the apex.

Median valves finely sculptured throughout, with minutely nodulose rays branching outward and forward from the jugum; lateral areas well differentiated, sculptured in zig-zag, and having two or three raised ribs formed by the more or less pustulose projections of the sculpture.

Posterior valve with the mucro post-median; ante-mucronal area sculptured similarly to the central areas; post-mucronal area having a distinct raised diagonal and sculptured weakly like the anterior valve, but with about twenty ribs only.

Girdle densely clothed with somewhat irregular oval striated scales, in eight to ten ridges.

Interior white. Slits, 8—1—9. (Figure on plate shows only 7 slits in the anterior valve, but one "tooth" is obviously abnormally unslit, the slit rays numbering eight).

Dimensions: 14 x 8 mm.

Station: On the under side or at margin of insertion in the sand of stones, dead shells or coral, between median and low tide marks.

Habitat: New Caledonia; not yet recorded from the Loyalty Islands.

Remarks. This shell is very common in the vicinity of Noumea, in the harbour, on the islands at the entrance, in the Baie de l'Orphelinat and on the Anse Vata. It is closely related to *Ischnochiton intermedius* Hedley and Hull, of Norfolk Island, but the sculpture is notably finer, and the colour variation is not nearly so great.

(b). *The Animal.*

External characters. The foot, ivory-coloured, is rather narrow. The mouth is surrounded by a hood-like fold extending laterally to frame the anterior portion of the foot (Fig. 1). The anus, situated quite near the posterior extremity of the foot, is oval in form, the largest dimension transversally. Twenty-two or 23 gill-rows may be counted on each side of the body. These gill-rows disappear a little behind the anterior extremity of the foot, and extend right up to the posterior extremity (Figs. 1 and 2). The gills have a bulky axis, carrying numerous lamellae. Fig. 3 shows the appearance of the gill, which one sees viewing the animal from its ventral surface; the point of the gill is directed towards the foot.

Appearance of the internal organs. The genital organs form a mass

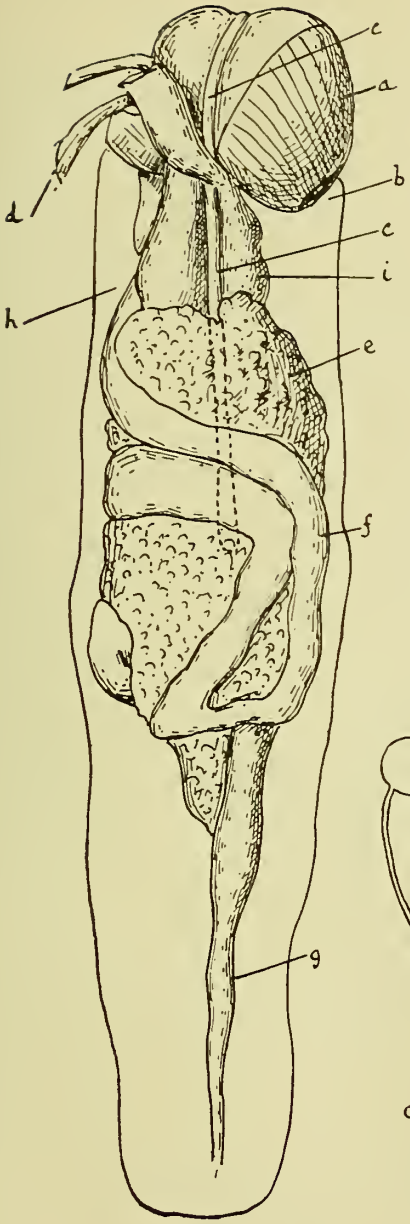
---

Explanation of Figures.

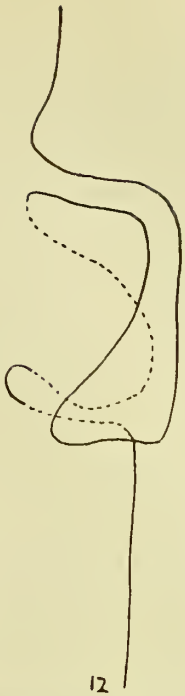
Fig. 11.—Digestive apparatus before dissection. The genital and renal organs are raised, as well as the heart. In the foreground the oesophagus has been pushed to the left so that the bulb may be seen. Towards the back the radular sac, hidden by the liver, is represented by dots. a—bulb, b—visible part of right cartilage, c—radular sac, d—strips belonging to the muscles attached to the anterior valve, e—liver, f—intestine, g—rectum, h—oesophagus, i—papillary sac. Magnification: 25.

Fig. 12.—Plan indicating the course of the intestine; the dotted parts are those which are hidden in Fig. 11.

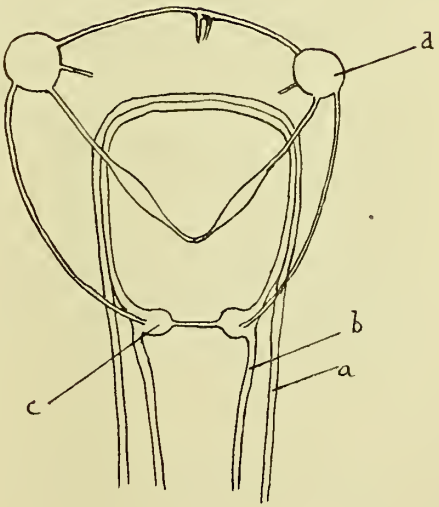
Fig. 13.—Central nervous system. a—cerebro-palleal cord, b—pedal cord, c—post-oesophageal ganglia.



11.



12



13

ISCHNOCHITON ACOMPHUS.
Figs. 11 to 13.

closely coupled to the valves. The glands remain attached to these valves when the latter are removed. A large mass is then found, consisting of the digestive canal, with extensive circumvolutions, and of the liver. The buccal bulb is found hidden in front by a great number of muscular tracts which are attached to the anterior valve.

Digestive apparatus. Fig. 11 shows the whole of the digestive tube in its natural position. The bulb is very large, and of a dark red colour. The cartilages show at the lower part, having the appearance of an ivory coloured region, spotted with black at the point where the muscles which end laterally at the radular sac diverge. The radular sac is greatly developed; its extension is indicated by dotted lines in Fig. 11, the posterior portion being hidden by the liver and intestine. Below the rotella, behind the mouth, the sub-radular organ is found in the form of two slight projections, facing the upper plane, coupled as shown in Fig. 4. The oesophagus, very soft at the side, covers the bulb, and the radular sac in front. It contains the two papillary sacs furnished with numerous closely packed papillae. These papillae, greatly developed, are simple, at the side indented only, not branched (Fig. 7). The radula shows from 40 to 45 completely developed rows. The central tooth is very variable. Examined under the microscope alone its form is difficult to interpret. The base widens behind in lozenge form, narrowing in front, until it rises in a median crest which projects in a slightly hooked cusp. Fig. 9 shows the central tooth viewed laterally. The first lateral shows at its outer margin a slightly projecting ledge. The second lateral is greatly developed. It shows two very strong rounded cusps, coloured dark yellowish-brown, nearly black on the free edge; the colour becomes lighter towards the base of the tooth. Fig. 8 gives one of the aspects which the second lateral can present. Beyond the third lateral the projecting palette comes; its terminal enlargement is shown in Fig. 10. It will be seen that the axis becomes narrower as it extends. The other teeth do not present any special character; their shape is indicated in Fig. 15.

The oesophagus, behind the bulb, and at the outlet of the papillary sacs, presents the most interesting arrangement of the system. It widens into a flattened pocket (stomach) passing beneath the radular sac. Fig. 6 shows this in its natural position. Fig. 5, on the other hand, shows the stomach drawn back beneath the radular sac, viewed laterally. The wall of this stomach is very thin and transparent. The intestine which proceeds from it describes convolutions embedded in the lobes of the liver. This relatively simple survey is indicated in diagram 12 annexed to Fig. 11. The rectum is rectilinear, and its diameter diminishes progressively towards the anus.

Nervous system. The two cerebro-palleal and pedal cords are coupled in front of the mouth. They diverge only when the pedal cords meet the two ganglia, situated immediately behind the buccal orifice. These ganglia are joined by a commissure. The ganglion masses situated behind the mouth divide to right and left into a long coupling which terminates in the ganglion lying at the opening of the oesophagus on the bulb. These ganglia, which are spherical, are far removed from the cerebro-palleal and pedal cords. They divide in front of the nerves which anastomose in front

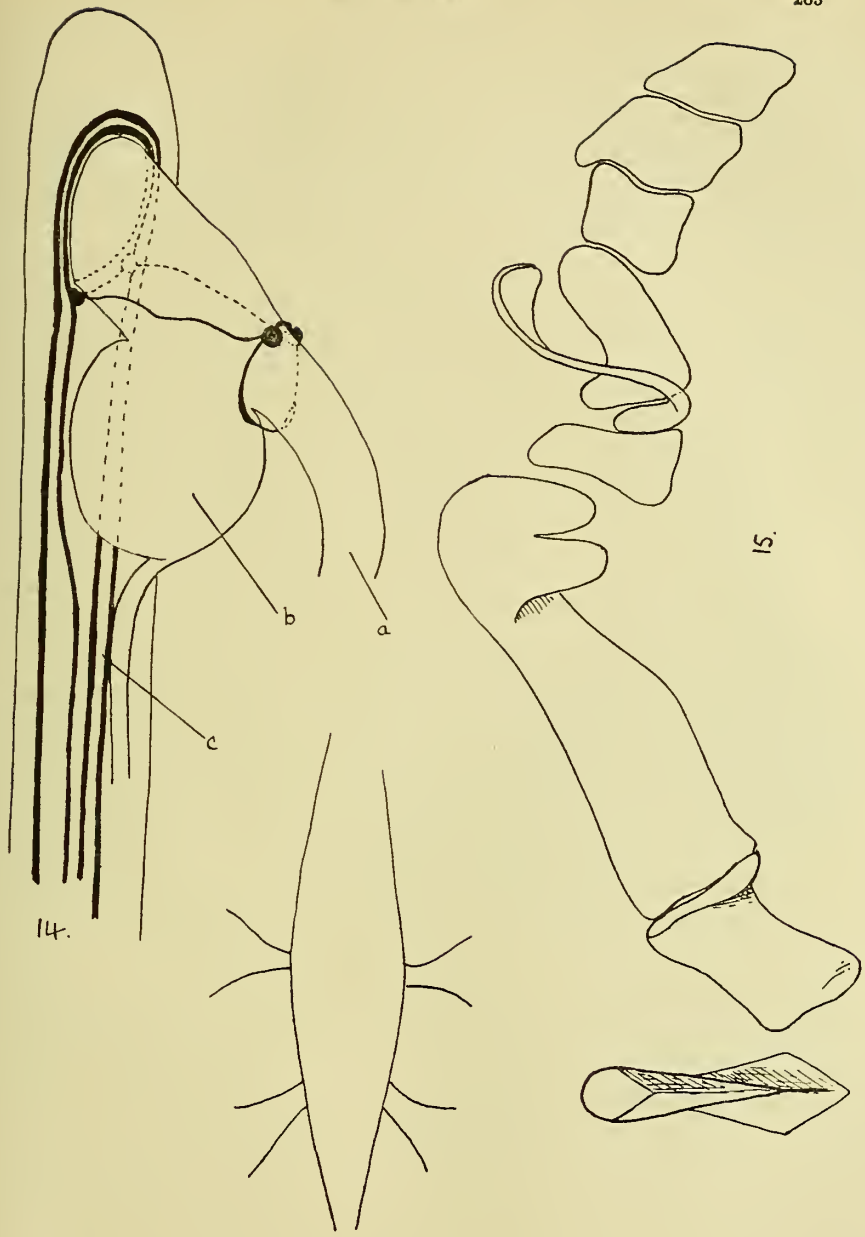
---

Explanation of Figures.

Fig. 14.—Plan showing the correspondence between the nervous system and the digestive apparatus. a—oesophagus, b—bulb, c—radular sac.

Fig. 15.—Half row of radular teeth. Magnification: 400.

Fig. 16.—Heart.



ISCHNOCHITON ACOMPHUS.
Figs. 14 to 16.

of the oesophagus and behind the couplings which meet again, so that a complete nervous ring surrounds the oesophagus at this level. The posterior couplings each carry a fusiform swelling.

Reproductive apparatus. The genital gland is white in the male, yellowish in the female. The posterior part of the female gland is shown in Fig. 17. The posterior point is situated immediately behind and above the rectum.

Circulatory system. The form of the heart is outlined in Fig. 16.

(c). *Reproduction.*

It has been possible to observe the laying of eggs in a glass vessel filled with sea-water which makes direct observation under a binocular microscope possible. An Ischnochiton collected on March 15th, 1930, laid on March 17th, that is to say, three days after the full moon of March 14th. Before this larvae had been obtained without observation of the egg-laying, specimens had been collected at full and at new moon tides, and the egg-laying must have taken place at the same time. It is owing to the times of spring tides being most convenient for research that the common belief has arisen that Loricates normally lay their eggs at full moon. General application should not be made too readily from these observations, as the result of the preceding observation indicates.

In order to lay its eggs, the Ischnochiton raises the posterior part of its girdle in an arc. It moves from time to time during the extrusion. The ventral surface of the animal was observed through the side of the glass. It was close to the surface of the water. The emission of the eggs is fairly rapid, about one per second, but irregular, two or three eggs sometimes being extruded at the same time. As the light fell on the dorsal surface of the animal, one could see by the transparency, the eggs being extruded to the right and to the left of the edge of the foot. They began to emerge fairly slowly, and were then suddenly propelled abruptly to a distance of about 4 millimetres. The position of the female being given, the majority of the eggs fell to the bottom of the glass vessel, but some remained attached to the side of the glass or to the girdle.

The eggs are visible to the naked eye like a fine dust. They are yellow in colour and the egg-mass is quite opaque. They are surrounded by a transparent envelope and furnished with a great number of papillae, which give them the appearance of little sea-urchins (Fig. 21). The papillae are planted one beside the other in a regular manner following the circles on the sphere in parallel planes (Fig. 22). The flexible papillae carry at their extremity four hooks directed towards the bulk of the egg. The following results were obtained when an egg was measured: diameter of egg 196 μ,

Explanation of Figures.

Fig. 17.—Posterior part of the genital gland.

Fig. 18.—Young larva at time of hatching. a—eye, b—boundaries of valves in formation, c—surface carrying tubercles in formation, d—ciliated furrow. Magnification: 250.

Fig. 19.—Larva one day after hatching. a—zone furnished with papillae (girdle). Magnification: 270.

Fig. 20.—Larva two days after hatching. Magnification: 270.

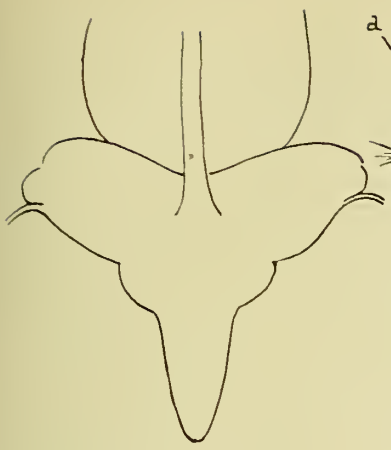
Fig. 21.—Egg. Magnification: 160.

Fig. 22.—Plan showing regularity of insertion of papillae on the shell of the egg.

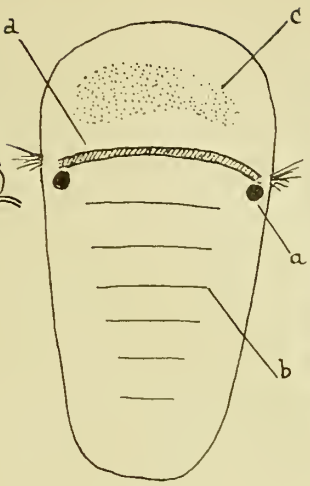
Fig. 23.—View of enlarged tubercules of larva two days after hatching.

Fig. 24.—Extremity of papillae on the shell of the egg. Magnification: 6,000.

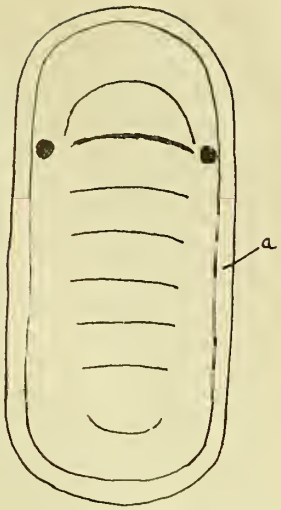
Fig. 25.—A papilla. Magnification: 1,000.



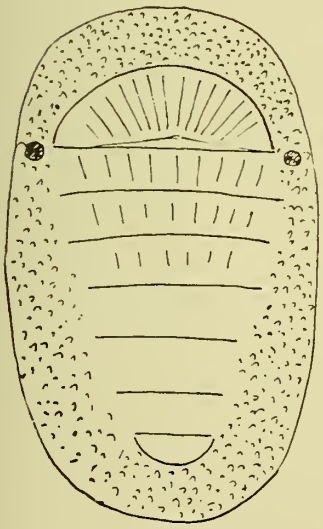
17.



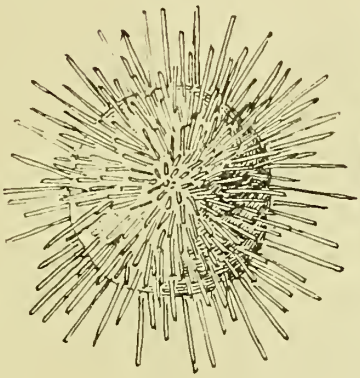
18



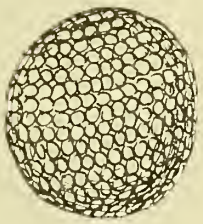
19.



20.

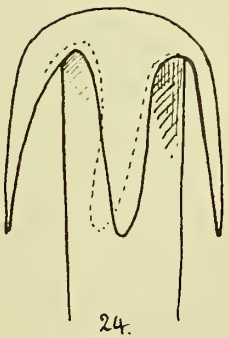


21.



22

23.



24.

25

ISCHNOCHITON ACOMPHUS.
Figs. 17 to 24.

length of a spine (all of equal height) 84 μ, length of hooks of spine 5 μ. These hooks enable the eggs to attach themselves to surrounding bodies.

Among the eggs extruded a certain number preserved their yellow, slightly greenish, coloration, and succeeded in developing. A considerable number of the others (doubtless under the influence of bacterial infection) took on a beautiful bright red coloration, and afterwards underwent decomposition.

Development is extremely rapid. On March 20th the hatching of an egg was observed. The larva completely fills the egg-shell and distorts it by its contraction. The split shell is then abandoned (it remains transparent and with its papillae intact). As soon as the larva is free it crawls rapidly. Fig. 11 shows the course of hatching. The body is divided into two parts by a deep furrow which shows in contrast by its deep green colour. The deep reddish eyes are clearly visible at the extremities of and a little behind the furrow. Behind the furrow six faint lines indicate the divisions between the valves in formation. The rear-most of these lines seems to correspond to the posterior part of the last valve. The girdle is already indicated by spiny projections, which are already marked, above all, on the posterior half of the furrow. At the point where the furrow meets the circumference of the body, one may easily see the very active ciliary projections constantly moving. All the anterior part of the body shows on its circumference the movement of tiny ciliary projections. These, which are visible only at the periphery, extend, no doubt, over the whole surface of the furrow. The boundaries of this deep green furrow are a little irregular. It is closely covered with ciliary projections over all its surface. In front of it numerous tubercles are seen forming, but at a certain distance from its anterior edge, in a zone indicated by dotted lines in Fig. 18. This is the anterior zone of the girdle. The zone is asymmetrical, as indicated by the figure. A day later, the larva presented the aspect indicated by Fig. 19. The eyes were a little less clear and relatively diminished. The girdle was provided with transparent papillae over a little width. The foot was as wide as the whole of the body with its girdle, and was very thick. The length of the larva was then 285 μ. Observations made on the valves, compared with those of the previous day, were rather disconcerting; only seven valves were to be seen. One of these, being placed in the position of the eyes, seemed to be formed in the anterior zone of the furrow, its posterior limit being also more clearly defined than those of the other valves. It might be thought that the six furrows of the larva at the preceding stage, also weakly defined, did not correspond to the intervals between the successive valves, but that the last furrow marked the posterior margin of the last valve.

The larva aged five days (from date of extrusion of egg) is shown in Fig. 20. The eight valves are developed. The first is very wide, the others progressively narrower, the last being greatly reduced. On the girdle are large papillae, of which a greatly magnified view is given in Fig. 23. The first valves show the beginning of their sculpture, the furrows thus formed becoming weaker towards the rear. The eyes are visible by means of the transparency, but are actually situated on the edge of the foot (they may sometimes be seen on the foot exposed beyond the girdle). From this moment the larva possesses most of the characteristics of the adult.

(The position of the eyes in the larva is not always the same. In a larva of four days, observed on August 27th, the left eye was shown situated much farther back than the right eye, this latter being in the usual position; the left eye was placed a little towards the anterior half of the body).

(To be continued.)